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Case Report

A Step-by-Step Approach to Free Fibula Flap Mandible Reconstruction of Mandibular Pathologic Fractures: A Pictorial Essay

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Abstract

Background: Pathologic fractures of the mandible following radiation and embolization can be a challenging problem for patients. Occasionally, patients have already completed the oncologic component of their treatment and are trying to move on with their lives. A pathologic fracture is not only painful, but also a frustrating hindrance as it limits food intake and overall nutrition. In addition, pathologic fractures are challenging to repair.

Purpose: To demonstrate a step-by-step approach for pathologic mandibular fracture repair with an ipsilateral free fibula flap following oncologic resection of a tonsillar tumor that underwent pre-operative embolization and post-operative radiation therapy.

Methods/Results: A 65 year old male presented with a tonsillar head and neck tumor. The patient had pre-operative embolization for an intra-oral bleed, successful resection with clear margins, and then post-operative radiation therapy. During a subsequent dental procedure, the patient developed a pathologic mandibular fracture with subsequent pain and malocclusion including a posterior open bite. The pathologic mandible fracture was repaired with and ipsilateral free fibula flap. A chart review was completed to create a pictorial essay to describe our technique.

Conclusion: Successful repair of pathologic mandibular fractures can be rewarding for the operative surgeon and satisfying for the patient. Optimizing chances of success are improved with pre-operative CT scans and orthodontic models as well as intra-operative models. A step by step intraoperative approach is helpful for maximizing success and optimizing occlusion.

Introduction

Pathologic fractures of the mandible are rare [1-5]. Defined methodology on how to treat them is not standard [1,4,6-8]. Repair of bone or soft tissue following radiation and osteoradionecrosis are challenging problems. Not only are tissues more hostile and blood supply compromised, but risk of infection and post-operative complications are more likely. The social challenges are heightened as well. Patients have completed successful surgical excision, chemotherapy, and radiation. They have thankfully resumed a "normal" life and can be frustrated with the introduction of a setback. Treatment

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of pathologic fractures of the mandible from osteoradionecrosis varies on age and overall medical health of the patient [4,8]. In the young healthy patient, adequate treatment can include resection of the osteoradionecrosis segment and replacing it with a vascularized bone graft. This requires additional surgery and often a gastrostomy tube and tracheostomy to protect the repair and for safety.

When head & neck, and plastic & reconstructive surgeons are in practice early on, they are presented with many difficult cases. This reconstruction is particularly complicated as it is important to retain the functional teeth, maintain the patient's occlusion, and construct a fibula flap that is small enough to be inset to fill the resulting defect of the resection. While larger tumors or resections require larger bone grafts, the smaller segments of bone are removed to retain functional teeth. Given the rarity of pathologic fractures and their treatment, it is hard to find a solution to approach this scenario in a textbook; and operating without planning can lead to the pitfall of post-operative malocclusion. Repairing pathologic fractures in the radiated and embolized setting is not straightforward and should be accomplished carefully. The pathologic malocclusion first requires establishing appropriate dental occlusion, followed by surgical resection, and finally, free vascularized tissue as the surrounding tissue is hostile to other methods. We present a step-by-step approach to this difficult problem so that Head & Neck or Plastic & Reconstructive surgeons can use it as a reference when trying to manage these surgical problems.

Methods

A photographic chart review was conducted on our patient who developed a pathologic fracture of the mandible after a prior history of successful tonsillar cancer treatment. The 65 year old male patient had preoperative embolization for an intra-oral bleed, successful tonsillar resection with clear margins, and then postoperative radiation therapy. During a subsequent dental procedure, over one year after radiation therapy, the patient developed a pathologic mandibular fracture with subsequent pain and malocclusion including a posterior open bite.

A panorex, as well as a pre-operative anatomic fine-cut CT-scan of the face/mandible, was obtained. The estimated bone resection of the pathologic fracture was 4 cm. Given the previous embolization and radiation therapy, vascularized fibula was selected for autologous reconstruction. Dental models of the maxillary and mandibular teeth were obtained from the patient's dentist to better understand the occlusal alignment. Synthes intra-operative models and occlusal splints were created to facilitate occlusal alignment. Photographs obtained intra-operatively as well as photos of the pre-operative plan were used to develop a step-by-step approach for head & neck and plastic & reconstructive surgeons to use as a surgical flight plan.

Adjunctive treatments include G-tube placement for nutrition while awaiting intraoral wound closure, hyperbaric oxygen therapy for facilitating healing in the radiated bed, and Head & Neck occupational therapy for relieving jaw stiffness.

Results

The appropriate medical clearance was achieved. The patient was taken to the operating room, and the surgical flight plan created was followed with photographs of the representative steps of the operation (Figures 1-16).

Discussion

Pathologic fractures of the mandible occur infrequently, and the surgical management will depend on the etiology of the fracture and the patient. The treatment of these fractures and their repair are technically challenging but rewarding for the operating team and the patient. In our patient, the malocclusion and the pain were the operative indications for surgical resection and reconstruction. In the re-operative patient, we have found

Figure 1: Pre-operative photographs of a 65 year old male with malocclusion and open bite after pathological fracture of left mandibular angle. The patient had previous successful treatment of a left tonsillar cancer with embolization, surgical excision, and radiation therapy.

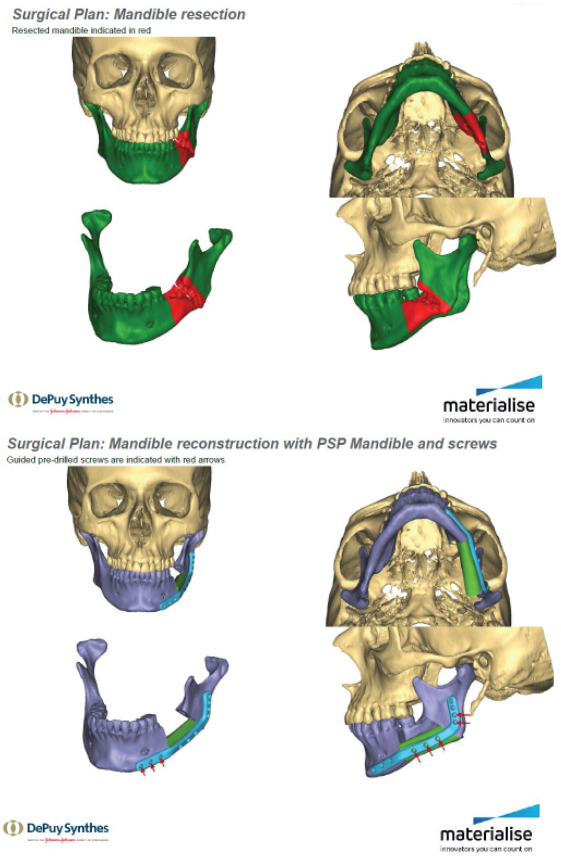

Figure 2: CT-scan of the patient's face and Synthes 3D reconstruction was obtained to understand the fracture pattern and facilitate a surgical flight plan for the resection of the pathologic fracture. A 4 cm resection and bone gap were anticipated. An autologous free fibula flap was chosen to be stabilized with a Synthes locking plate.

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that taking necessary precautions in all steps of the planning is helpful to maximize outcome. Often in the re-operative and frustrated patient, there is an overtone of trying to appease the patient and not cause further inconvenience. In our experience, it is important not to omit any standard pre-operative or operative steps to placate the patient despite their frustration. Reiterating to the patient that measures such as gastrostomy tube, tracheostomy, etc. are needed for safety will help the re-operative patient to understand. It is important to reiterate the success of their cancer treatment.

Figure 3: A Synthes 3-D model of the CT-scan was created to facilitate surgical planning and help identify size and angle of mandibular and fibular osteotomy. While these models help angle of osteotomy, they do not establish or set occlusion. Occlusion will need to be established prior to osteotomy in the operating room. This is an important part of planning. Intra-operatively, all steps were taken to ensure patient safety in the post-operative period in the intensive care unit.

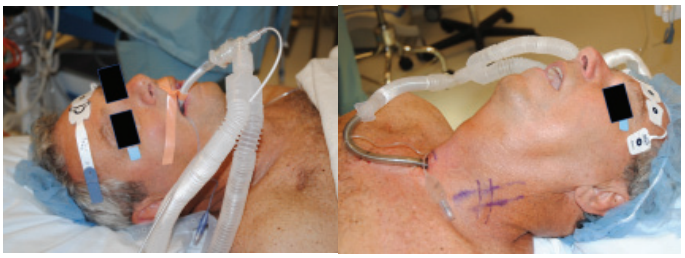

Figure 4: Step 1. General endotracheal anesthesia was undertaken. The endotracheal tube was converted into a tracheostomy for airway protection and swelling post-operatively and to facilitate anesthetic delivery in case of a return trip to the operating room for flap or bleeding emergencies.

Figure 5: Step 2. Place arch bars. Prior to the surgical field prep, the arch bars were placed with the intention to establish occlusion and maintain post-operatively in gliding elastics. The arch bars are the key to occlusal alignment. Pathologic fracture treatment is different than a primary resection where a patient has normal occlusion pre-operatively.

Figure 6: Step 3. Expose the mandibular fracture. This is an important step. Wide exposure of the fracture was undertaken intra-orally and extra-orally for resection and irrigation of the osteoradionecrosis. The wide exposure allows easy mobilization of the mandible to re-establish occlusion.

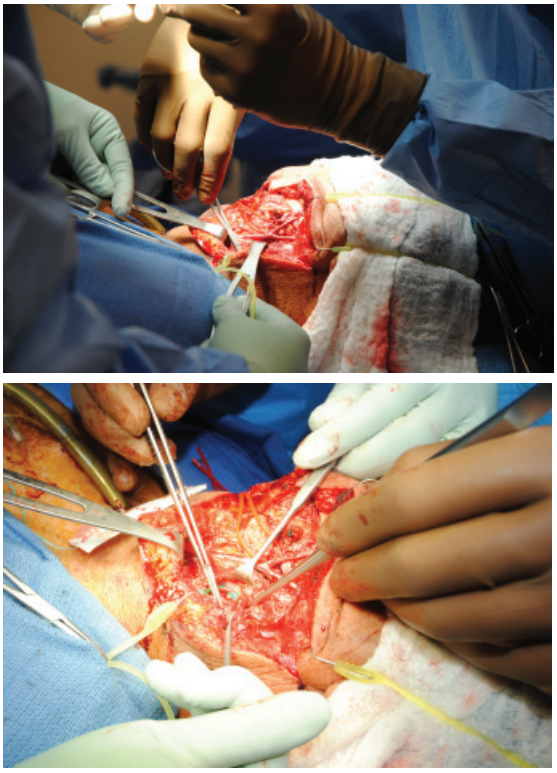

Figure 7: Step 4. Expose the recipient vessels. In patients with prior embolization or head and neck surgery preoperative ultrasound is helpful. The external jugular vein and facial vein were exposed to have dual venous drainage. The facial artery was exposed, however, contained a coil from previous embolization and was unusable. Proximal dissection was required to access the superior thyroid artery. Pre-operative ultrasound is helpful in previously radiated and embolized settings for surgical planning.

The impetus for this article was to create a step-by-step approach to mandibular resection and reconstruction in the patient with pathologic fracture so that when we, or other head & neck or plastic & reconstructive surgeons encounter a similar patient scenario, they can follow this guideline in a easily reproducible manner. The techniques themselves are not novel or unique, but rather involve steps from different procedures combined into one. What is important about the

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pathologic fracture reconstruction is that the occlusion is not normal to begin with. Unlike a traditional resection and reconstruction, the occlusion is often normal or normal enough to be maintained. In our patient it was important to first to recreate and mobilize the fracture and re-establish occlusion before embarking on resection and reconstruction.

In the patient who had previous embolization and previous surgery and radiation, we find that a pre-operative ultrasound of the neck to look for arterial and venous recipient vessels is helpful. The vascular ultrasound can not only detect flow,

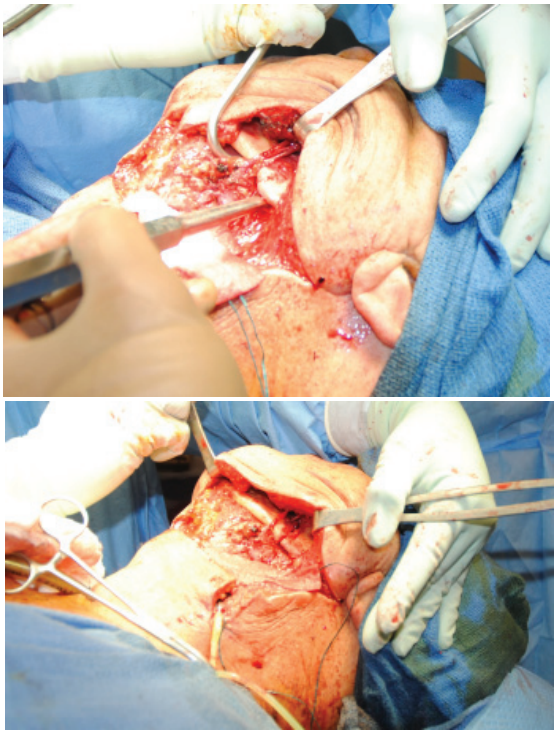

Figure 8: Step 5. Recreate the mandibular fracture and mobilize the mandible. The pathologic fracture is easily identified with a fibrous non-union after wide exposure. Osteotomy through the fibrous non-union allows the mandibular segments to move, to help re-establish occlusion.

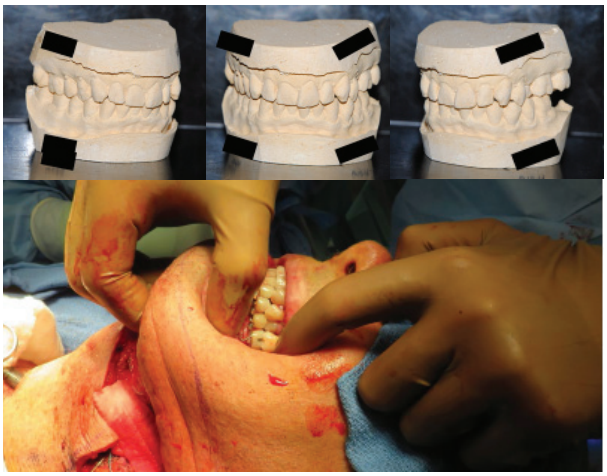

Figure 9: Step 6. Re-establish the occlusion of the teeth intra-operatively. Take your time with this step and make sure the teeth align properly from all angles. Dental models are extremely helpful. Make sure the condyle swings. This is an important step prior to pre-plate placement as this will help to set the final post-operative occlusion.

Figure 10: Step 7. Using the dental wires, bring the patient into appropriate maxillomandibular fixation.

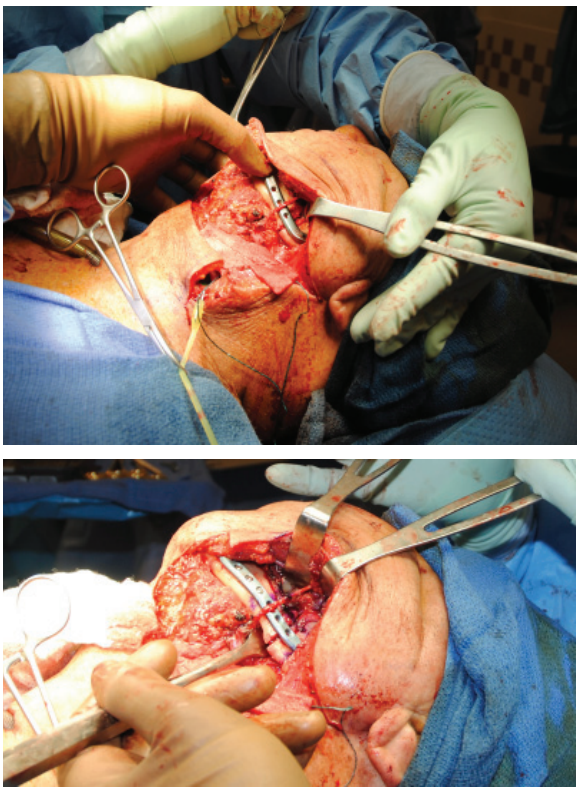

Figure 11: Step 8. While the patient is in stable maxillomandibular fixation place the plate on the mandible. Spend time with the position of the plate on the mandible. The wide exposure helps to gain visualization of all aspects of the mandibular plate. No matter how many times this is done for mandible fractures or reconstruction, one can never check or re-check this positioning enough. The plate can easily rotate after drilling. Drilling the most proximal and distal holes first helps to maintain the position in the extreme ends and all points in between. Once the screws have been placed, the patient can be taken out of maxillomandibular fixation and occlusion can be double checked.

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but also diameters of veins and arteries to help select larger diameter vessels or select for favorable size matching. In this patient, the facial artery underwent preoperative embolization as the patient had experienced bleeding. Although we dissected out the facial artery, the presence of a coil and absence of flow made it unusable for anastomosis. The superior thyroid was dissected out and utilized. The diameter of the superior thyroid vessels was small, but the size matched favorably when anastomosed to the peroneal artery. An important step order is to make sure the recipient vessels are available prior to the osteotomies. If recipients are not available, alternative options need to be considered.

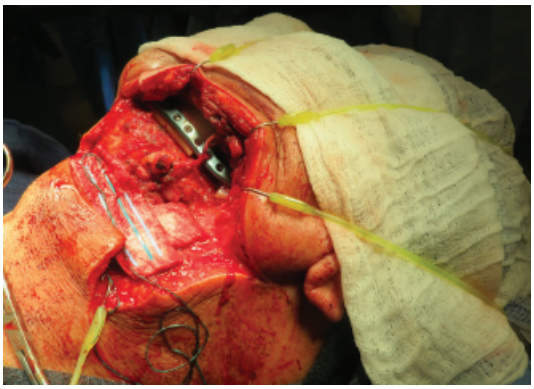

Figure 12: Step 9. Resect the pathologic fracture site back to a healthy bleeding bone edge. In this case, the object was to preserve all functional teeth as long as there was no osteomyelitic bone or necrotic bone. This is different than the patient with a malignant tumor of bone. Keeping the plate in place facilitates the oscillating saw. Removal of the plate then facilitated the final osteotomy. The plate is returned to the mandible at the location where the holes were pre-drilled.

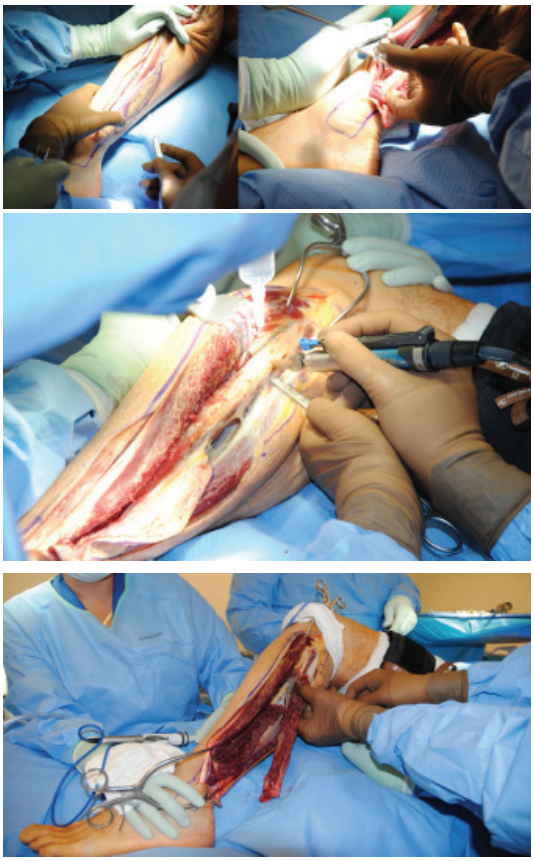

Figure 13: Step 10 Harvest the Fibula Flap. After making the anterior skin incision, use the back end of the scalpel to bluntly dissect posteriorly to identify the perforator. Once the perforator is identified, the peroneus longus and brevis can be retracted anteriorly and will make the dissection easier. Make the distal osteotomy and then proximal osteotomy in usual fashion.

Figure 14: Step 11. Contour the fibula flap. This could be accomplished with a ruler or tongue depressor as a model or the 3-D CT scan model. Grasping the fibula with Kocher clamps are helpful for stabilization during the osteotomy. The resulting defect that was created was 3cm. The osteotomies were completed, and the fibula flap was brought to the mandibular defect.

Figure 15: Step 13. Stabilize the fibula flap with screw fixation to the mandibular reconstruction plate. Once stabilized, perform the microvascular anastomosis. The fibula skin is deepithelialized leaving a small skin paddle to monitor with doppler and examine flap color. Inset the flap and close the neck wound.

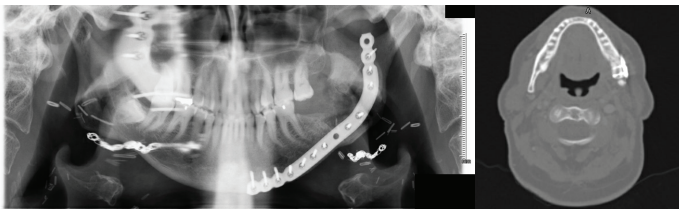

Figure 16: Postoperative Panorex showing normal occlusion was obtained as well as a CT-scan showing the free vascularized fibula flap with stable fixation of the mandible.

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Conclusion

Head & neck reconstruction is a challenging and humbling field of surgery, but nonetheless rewarding. This surgical case encompasses many different surgical principles, the most important are surgical planning and safety. In early stages of one's career, it is helpful to maintain a photo journal of maneuvers performed. This can help for future cases the surgeon encounters and serve as a measure for improvement in outcomes, efficiency, and to minimize complications.

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